

Purchase Specification
For
Main Turbine Generator (MTG) Exhaust Ducting System

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1.0 Introduction

- 1.1** This specification establishes the requirements for the design, manufacture, and delivery of an Exhaust Ducting System for a gas turbine on a Gas Turbine Test Facility at the Naval Surface Warfare Center, Carderock Division, Ship Systems Engineering Station (NSWCCD-SSES), Philadelphia, PA. The Exhaust Ducting System is shown in Figure 1. The Temporary Exhaust Gas Exit Section (Figure 3) is an option.
- 1.2** Each of the system's components, specified herein, shall be fabricated, assembled, and shipped in as much a complete unit as possible.
- 1.3** All components described in this specification must be designed to be structurally and thermally adequate to withstand lifting and handling, load conditions, and the operating conditions as described in this specification.

The Exhaust Ducting System is to be delivered to NSWCCD-SSES no later than 16 weeks after Date of Contract.

2.0 Scope

2.1 Equipment and Services to be Provided by the Contractor:

- 2.1.1** The Contractor shall be responsible for delivery of the following to NSWCCD-SSES in Philadelphia:

Item	Qty	Description
0001	1	Main Turbine Generator Exhaust Ducting System in accordance with the specifications provided herein.
0002	1 Lot	Preliminary Technical Data consisting of preliminary drawings, estimated loads, thermal growth calculations and proposed quality assurance plan in accordance with paragraph 5.1 of this specification.
0003	1 Lot	Interim Technical Data for SSES review and comment consisting of: flange and bolting details, component geometry, Bill of Material, a calculation report with analysis of the structural and thermal adequacy of the system, exhaust system 1 st mode natural frequencies, weights, loads at support points, centers of gravity and lift points for each component per paragraph in accordance with paragraph 5.2 of this specification.
0004	1 Lot	Three (3) sets of 'As Built' drawings and erection instructions.
0005	1 Lot	Completed quality assurance plan

0006	1	Option: Temporary Exhaust Gas Exit Section (priced separately)
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- 2.1.2** The Contractor shall be responsible for providing the Exhaust Ducting System as specified herein including all bolting hardware to make-up the flange joints (with 10% spares).
- 2.1.3** The Contractor shall be responsible for the design, procurement of materials, fabrication, cleaning, surface preparation, painting, packaging and shipping of all items included in this specification. The Contractor shall assume the responsibility of the product in transit.
- 2.1.4** The Contractor shall size and provide the appropriate gaskets for all flange joints. Thermal expansion is to be considered when sizing gaskets.
- 2.1.5** The design of structural steel shall be in accordance with the specification of the American Institute of Steel Construction, latest edition, except where modified by local government regulations or Government's special requirements. Modifications for local government regulations or Government's special requirements shall be made only if they exceed the requirements of the Codes.
- 2.1.6** All ducting component sections shall have hardened lift points to allow lifting and movement. These lift points shall be designed where possible to lift through the system component center of gravity. Temporary shoring shall be designed, manufactured, and provided with the duct components to facilitate movement. Where the integral strength of a component section will not allow free standing storage, storage stands shall be designed, manufactured and provided. All design drawings and hardware shall have centers of gravity calculated and clearly marked. Where the component sections have been made symmetrical, lift points shall be symmetrically placed on both sides of the component section.
- 2.1.7** The Contractor shall be responsible for the accuracy of its designs and full conformance to the requirements presented in this specification. Approval of any drawings, calculations and/or tests by the Government shall not relieve the Contractor from these responsibilities.
- 2.1.8** Nothing in this specification shall relieve the Contractor of the responsibilities for performing, in addition to the requirements of this specification, such analyses which the Contractor considers necessary to insure that the design, material, and workmanship are satisfactory for the service intended, or as may be required by common usage and/or good practice.
- 2.1.9** Inspections shall be performed as hereinafter specified.

- 2.1.10** The Contractor shall maintain all hereafter-specified data and records. These will be delivered to the Government after the work has been accepted.
- 2.1.11** The Contractor shall establish and maintain a system for the control of quality during manufacture and examination, which will insure that all components and assemblies furnished under this specification meet requirements hereinafter specified.
- 2.1.12** The Contractor shall mark all parts and units of assembly as hereinafter specified.
- 2.1.13** The Contractor shall, prior to shipment, assemble the Exhaust Ducting System to ensure adherence to the tolerances indicated by this specification. The Government or the Government's agent shall witness the assembly by the Contractor. A minimum notification of seven (7) days is required to arrange such a visit.
- 2.1.14** The Contractor shall provide the Government and his agent access at all times to all places where work is being done under this specification. They shall have full access to facilities for unrestricted inspection of such work.
- 2.1.15** The Contractor shall provide all necessary and incidental labor, materials, tools, equipment and services that must be employed to satisfy the requirements stated in this specification.
- 2.1.16** The Contractor shall provide, for review and approval, all of the data requirements described in this specification, including the complete and detail drawings for all equipment and work under this specification.
- 2.2** Equipment and Services to be Provided by the Government:
- 2.2.1** The Government will unload at NSWCCD-SSES, store and erect all items furnished by this specification.
- 2.2.2** The Government will modify an existing support structure at the Test Facility to support the Exhaust Duct System, as required.
- 2.2.3** The Government will modify the existing roof penetration in the building to accommodate the Exhaust Duct System.
- 2.2.4** The Government will provide flexible joints at the ducting interface with the gas turbine and the Exhaust Gas Exit Section at the time of erection.

- 2.2.5** The Government will provide and install pressure and temperature sensing instruments at the instrumentation connections on the Transition Section following erection.
- 2.2.6** The Government will provide grounding cables as required following erection.

3.0 Applicable Documents

- 3.1** The following specifications, standards, and codes, latest edition, form a part of this specification. The design of the items identified in this specification shall be in strict compliance with all applicable sections herein.

3.2 Referenced Specifications, Standards, and Codes

- 3.2.1** American Society of Mechanical Engineers (ASME), Standard STS-1 "Steel Stacks"
- 3.2.2** American Society of Civil Engineers (ASCE), Standard 7-02 "Minimum Design Loads for Buildings and Other Structures"
- 3.2.3** American Welding Society (AWS), Standards D1.1 "Structural Welding Code – Steel", D9.1 "Sheet Metal Welding Code", and D10.12 "Guide for Welding Mild Steel Pipe"
- 3.2.4** American Institute of Steel Construction, Inc. (AISC), ASD 9th Edition.
- 3.2.5** American Iron and Steel Institute (AISI)
- 3.2.6** American Society for Testing and Materials (ASTM), Standards A36, A105, A106, A176, A181, A240, A325, and A563
- 3.2.7** American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) Standard 52-76
- 3.2.8** American National Standards Institute (ANSI), Standards B1.20.1 "Pipe Threads, General Purpose (Inch)", B16.11 "Forged Fittings, Socket-Welding and Threaded", B16.5 "Steel Pipe Flanges and Flanged Fittings"
- 3.2.9** Steel Structures Painting Council (SSPC)
- 3.2.10** International Building Code, 2003
- 3.2.11** Department of Transportation (DOT), CFR 49

- 3.2.12** American National Standards Institute (ANSI)/American Society for Quality Control (ASQC), Section Q, "Quality Systems - Model for Quality Assurance in Production and Installation"
- 3.2.13** Occupational Safety and Health Agency (OSHA), Part 1910 "Standards Improvement (Miscellaneous Changes) For General Industry and Construction Standards"

4.0 Technical Requirements

4.1 General

- 4.1.1** The Exhaust Ducting System shall be provided in accordance with paragraph 3.2. It shall collect hot exhaust gases from the gas turbine under test in NSWCCD-SSES Building 77H and direct the exhaust gases through a roof penetration and into an Exhaust Gas Exit Section located above the exit of the ducting system. The Exhaust Duct System shall be supported by an existing support structure, modified by the Government as required to support the new ducting and the Exhaust Gas Exit Section.

4.1.2 Site Conditions:

- 4.1.2.1** Location: Partially Indoor / Partially Outdoor
- 4.1.2.2** Ambient Temperature Range: -5°F to 105°F (outside air)
- 4.1.2.3** Relative Humidity Range: 05% to 100% (outside air)
- 4.1.2.4** Altitude: 33' above mean sea level at Gas Turbine Interface

4.1.3 Design Conditions

4.1.3.1 Applied Loading

The Exhaust Ducting System shall be designed for the following applied loads per Reference 3.2.1 except as noted.

- Dead Load
- Wind Load
- Seismic Load
- Thermal Load

- Flow Load resulting from Operating Conditions listed in Section 4.1.4
- Pressure Load resulting from Operating Conditions listed in Section 4.1.4

4.1.3.2 Allowable Stresses

Allowable Stresses in exhaust ducting shell material shall be in accordance with Reference 3.2.1. Allowable stresses in all other steel members shall be in accordance with Reference 3.2.4.

4.1.3.3 Operating Conditions

- The exhaust duct shall be designed for conditions no less than an exhaust gas flow rate of 282 lbs/sec and 985°F at 12" W.G.
- The contractor shall provide an engineering estimate of the outer shell temperature while operating at the design conditions. If the outer shell temperature is above 140°F, the Contractor shall offer design alternatives to lower the outer shell temperature to less than 140°F.

4.2 Arrangement

- 4.2.1** The Exhaust Ducting System shall be designed in accordance with the arrangement and details depicted in Figure 2.
- 4.2.2** The Exhaust Duct System shall be of double walled construction, designed such that the inner liner and outer shell are vertically and laterally independent of each other. The inner liner shall have the freedom to expand and contract with changes in exhaust gas temperature and outside ambient air temperature, independent of the outer wall of the duct without buckling, distortion, and/or failure. The inner liner shall have a smooth inside surface, which does not impede flow.
- 4.2.3** Construction shall be such that no gaps or leaks occur in the assembly. Flanged Joints shall be designed to minimize the exposure of the gaskets to hot exhaust gas.
- 4.2.4** The entire weight of the supplied Exhaust Duct System is to be supported by the two Duct Support Interfaces shown on Figure 2. The duct system shall include provisions to accommodate thermal expansion in the shell between the two fixed support points. The Exhaust Duct Transition Section shall be fully supported by its top flange and transmit no force to the flexible expansion joint, provided by the Government, at the gas

turbine interface. The temporary Exhaust Gas Exit Section above Exhaust Duct Top Section will take the place of the Exhaust Gas Diffuser and the Exhaust Gas Diffuser Flexible Joint. For this temporary use, the Exhaust Gas Exit Section will be supported by the Exhaust Ducting System. The Exhaust Gas Diffuser, once installed, will be supported separately and will be connected to the Exhaust Gas System through the Flexible Joint.

- 4.2.5** The Exhaust Duct Transition Section shall have twelve (12) ¼" connections for pressure instrumentation and four (4) ½" connections for temperature instrumentation. The connections will be configured as shown in Detail 3. The Government will provide exact locations after the award of a contract.
- 4.2.6** The Exhaust Duct Intermediate Section shall have a Contractor Designed Hinged Inspection Hatch as shown in Figure 2. A removable, interior ladder or permanent ladder rungs must also be provided from the Inspection Hatch down to the bottom of the Exhaust Duct Transition Section.
- 4.2.7** The Exhaust Duct Top Section shall have flashing to prohibit water entry into the building as shown in Figure 2.
- 4.2.8** The temporary Exhaust Gas Exit Section is to be of a single walled construction. It will be secured to the duct system on one end and will be able to thermally grow without restriction at the other end.
- 4.2.9** Lift points (eyes) shall be provided to permit loading, unloading, and erection.
- 4.2.10** The Exhaust Ducting shall have the following Gas Sample Ports:

Type	Quantity	Location	Detail
3" Diameter	1	86' Above Floor	5 inch square flange, See Figure 4
3" Diameter	1	81.25' Above Floor	5 inch square flange, See Figure 4
3" Diameter	1	70' Above Floor	5 inch square flange, See Figure 4
3" Diameter	1	32' Above Floor	5 inch square flange, See Figure 4
3" Diameter	12	Below the 32' Level, between the expansion joint and the transition section. See	5 inch square flange, See Figure 4

		Figure 5	
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4.3 Tolerances

4.3.1 Tolerances shall be in accordance with the following:

4.3.1.1 Ducting Tolerances:

4.3.1.1.1 Square Ducting shall maintain diagonal squareness of $\pm 1/8$ inch.

4.3.1.1.2 Round Ducting shall maintain the required diameter within $\pm 1/8$ inch.

4.3.1.1.3 All linear dimensions shall be $\pm 1/8$ inch.

4.3.1.2 Flange Tolerances:

4.3.1.2.1 Flatness of flanges shall be held within a tolerance of $\pm 1/8$ inch. Contractor shall insure that flanges will not be distorted due to the torque of bolts

4.3.1.2.2 Flanges shall maintain a parallelism or perpendicularity, as applicable, within a total tolerance of $\pm 1/8$ inch.

4.3.1.2.3 Square flanges shall maintain diagonal squareness of $\pm 1/8$ inch.

4.3.1.2.4 Round flanges shall maintain the required diameter within $\pm 1/8$ inch.

4.3.1.2.5 Location of all holes shall be held to a true position of $\pm 1/16$ inch diameter circle.

4.4 Materials and Processes

4.4.1 The external walls of the Exhaust Duct System shall be fabricated from ASTM A36 carbon steel plate, not less than 3/16 inches thick. The end flanges shall be 3/8" thick (min) ASTM A36 carbon steel. Welding shall be in accordance with AWS D1.1. All exterior duct welds are seal welds.

4.4.2 All surfaces exposed to hot exhaust gas shall be ASTM A-176, type 409 Stainless Steel. Stainless steel surfaces shall not be painted. The inner liner shall be free to expand and contract with changes in the exhaust gas temperature and outside ambient air, independent of the outer shell of the duct.

- 4.4.3** The Exhaust Duct System shall be insulated with 8 lbs/cu.ft. density Durablanket-HP-S Ceramic Fiber 2300°F. Between the stainless steel liner and carbon steel shell, thickness of insulation shall be in excess of 4 inches to prevent voids from occurring at installation.
- 4.4.4** Welding on the inner liner shall be in accordance with paragraph 3.2.3 above. No weld spatter is allowed inside the exhaust duct stainless steel liner. TIG welding of the liner shall be used if required. Other methods of fastening inner liner may be used if approved by the Government.
- 4.4.5** Welding in fabrication of the liner and shell shall be avoided through the use of bending. The Contractor shall provide details regarding fabrication with the design submittals.
- 4.4.6** Flanges shall be bolted with ASTM A-325, Grade-5, zinc plated hex head bolts with ASTM A-563, Grade-DH hex nuts and flat circular washers.
- 4.4.7** Surface Preparation and Painting
 - 4.4.7.1** Carbon steel surfaces (interior and exterior) shall be cleaned in accordance with SSPC-SP6 (3.2.9 above), Commercial Blast Cleaning. Dust and blast products shall be removed from the surface of sandblasted steel by high pressure air or vacuum cleaning.
 - 4.4.7.2** Paint all Carbon Steel interior and exterior surfaces with one shop coat of Carbo-Zinc HS-11 (Green) paint, 3.0 to 5.0 mils dry film thickness.
- 4.4.8** All structural welding shall be in accordance with AISC specifications in conjunction with the Structural Welding Code-Steel, AWS D1.1.

5.0 Data Requirements

5.1 Required three (3) weeks after Date of Contract:

- 5.1.1** Preliminary drawings of the Exhaust Duct System components giving sufficient details to allow evaluation of the exhaust system with regard to flange bolting arrangements, double wall construction, structural integrity, installation and conformance with major requirements of this specification.
- 5.1.2** Estimated loads at support points and centers of gravity of the exhaust ducting system components.

5.1.3 Thermal growth calculations for the Exhaust Ducting System which include the thermal growth between the two duct support rings, the resulting forces, and the thermal growth of the ducting into the gas turbine flexible joint and the exhaust gas diffuser flexible joint.

5.1.4 A proposed Quality Assurance plan in accordance with the requirements of ANSI/ASQC Section Q. This shall include work procedures performed by the Contractor or his contractor for the following:

- 5.1.4.1** Manufacturing and processing procedures
- 5.1.4.2** Inspection checklist or program
- 5.1.4.3** Cleaning procedures
- 5.1.4.4** Painting procedures
- 5.1.4.5** Shipping procedures
- 5.1.4.6** Repair welding procedures
- 5.1.4.7** Quality assurance checklist

5.2 Required six (6) weeks after Date of Contract:

5.2.1 Interim technical data and drawings for review and comment by the Government providing final location of the following:

- 5.2.1.1** Bolting patterns of all flange sections.
- 5.2.1.2** Final information on Exhaust Duct System components geometry, weights, and loads.
- 5.2.1.3** Bolting patterns on hold down bolts for the two duct support sections.

5.2.2 Bill of materials including part number, size, material designation, quantity and Contractor's name and part number for all subcontracted items.

5.2.3 A calculation report with the following information:

- 5.2.3.1** Analyses of the structural and thermal adequacy of the Exhaust Duct System components.
- 5.2.3.2** The Exhaust Ducting System 1st mode natural frequencies.
- 5.2.3.3** Loads at support points sufficient for the Government to confirm the adequacy of the existing support structure.
- 5.2.3.4** Weights, centers of gravity, and lift points for each component.

5.3 Required ten (10) weeks after Date of Contract:

5.3.1 Three (3) reproducible sets of the final source control drawings showing all the required details of this specification, additional details resulting from the Government's reviews, and any "As Built" details resulting during manufacture.

5.3.2 Complete and detailed erection instructions for the exhaust ducting system components. Lifting and erection instructions are to be part of the source control drawing. Three (3) sets of the erection instructions are to be shipped with the equipment.

5.3.3 Instructions for handling and storage of all equipment.

5.4 Upon completion of manufacturing and assembly of the ducting system, a completed quality Assurance Plan per paragraph 5.1.4 shall be provided.

5.5 Drawing Format Requirements

5.5.1.1 The drawing format must be clear. Numbers, letters, and lines must be clear and dark, maintaining uniform density and properly spaced to insure clarity when reduced in size.

5.5.1.2 The drawing title block must include title, drawing number, revision number, and date.

6.0 Release for Manufacture

6.1 Design Review

The Contractor shall furnish descriptions and drawings of the proposed exhaust ducting system components to the Government for review in accordance with Section 5. No fabrication work by the Contractor is authorized until formal release for manufacture is provided to the Contractor by the Government. Review and comment of drawings is not to be construed as relieving the Contractor of the responsibility for the fabrication of the exhaust system components and/or voiding of the Contractor's guarantees. Review and comment on preliminary design package will be 14 days after receipt by the Government.

6.2 Design Change Provision

6.2.1 No substitutes or alterations are authorized without written approval in the form of a change notice to the order.

7.0 Inspection and Testing

- 7.1 The Contractor shall notify the Government two weeks prior to the shipping date for the exhaust ducting system. The Government reserves the right to conduct an in-plant inspection of the pieces prior to packaging for shipment.

8.0 Delivery Schedule

- 8.1.1 Delivery shall be in accordance with the following schedule:

Item	Description	Weeks after date of Contract
0001	Main Turbine Generator Exhaust Ducting System in accordance with the specifications provided herein.	16 Weeks
0002	Preliminary Technical Data consisting of preliminary drawings, estimated loads, thermal growth calculations and proposed quality assurance plan in accordance with paragraph 5.1 of this specification.	3 Weeks
0003	Interim Technical Data for SSES review and comment consisting of: flange and bolting details, component geometry, Bill of Material, a calculation report with analysis of the structural and thermal adequacy of the system, exhaust system 1 st mode natural frequencies, weights, loads at support points, centers of gravity and lift points for each component per paragraph in accordance with paragraph 5.2 of this specification.	6 Weeks
0004	Three (3) sets of 'As Built' drawings and erection instructions.	16 Weeks
0005	Completed quality assurance plan	16 Weeks
0006	Option: Temporary Exhaust Gas Exit Section	16 Weeks

9.0 Shipping

9.1 Packaging

- 9.1.1** The Contractor shall provide shipping protection appropriate for the method of shipment and final destination. Preparation is subject to review and comment by the Government.
- 9.1.2** The Contractor shall pack, label and ship all equipment and materials in compliance with D.O.T. CFR 49.

9.2 Coding, Marking, Labeling, and Placarding

- 9.2.1** The Contractor shall provide a permanently attached nameplate with each exhaust ducting system. The nameplates shall display Contractor's address and purchase order number.
- 9.2.2** Each separate deliverable item shall be tagged or stenciled with the drawing number, part name, Contractor's part number or identification number, weight, center of gravity and lift points.
- 9.2.3** Any angles, bars, channels, etc., used for shipping and requiring removal before installation shall be painted yellow and clearly identified by stenciling in a contrasting color.
- 9.2.4** Instructions for proper storage at the job site (i.e. lift points, cable angles, etc.) shall be provided.

9.3 Shipping Instructions

- 9.3.1** The Contractor shall contact the Government two (2) weeks prior to packaging.
- 9.3.2** Each package shall be marked with the Contract Number, Contract Item Number and Purchase Specification Number TS050-13.
- 9.3.3** Shipping Address: Naval Surface Warfare Center,
Carderock Division
Ship Systems Engineering Station
901 Admiral Peary Way
Naval Business Center
Philadelphia, Pa 19112
Attn: Howard Feinstein, Code 9112
Phone: (215) 897-8895
Cell: (215) 837-1787

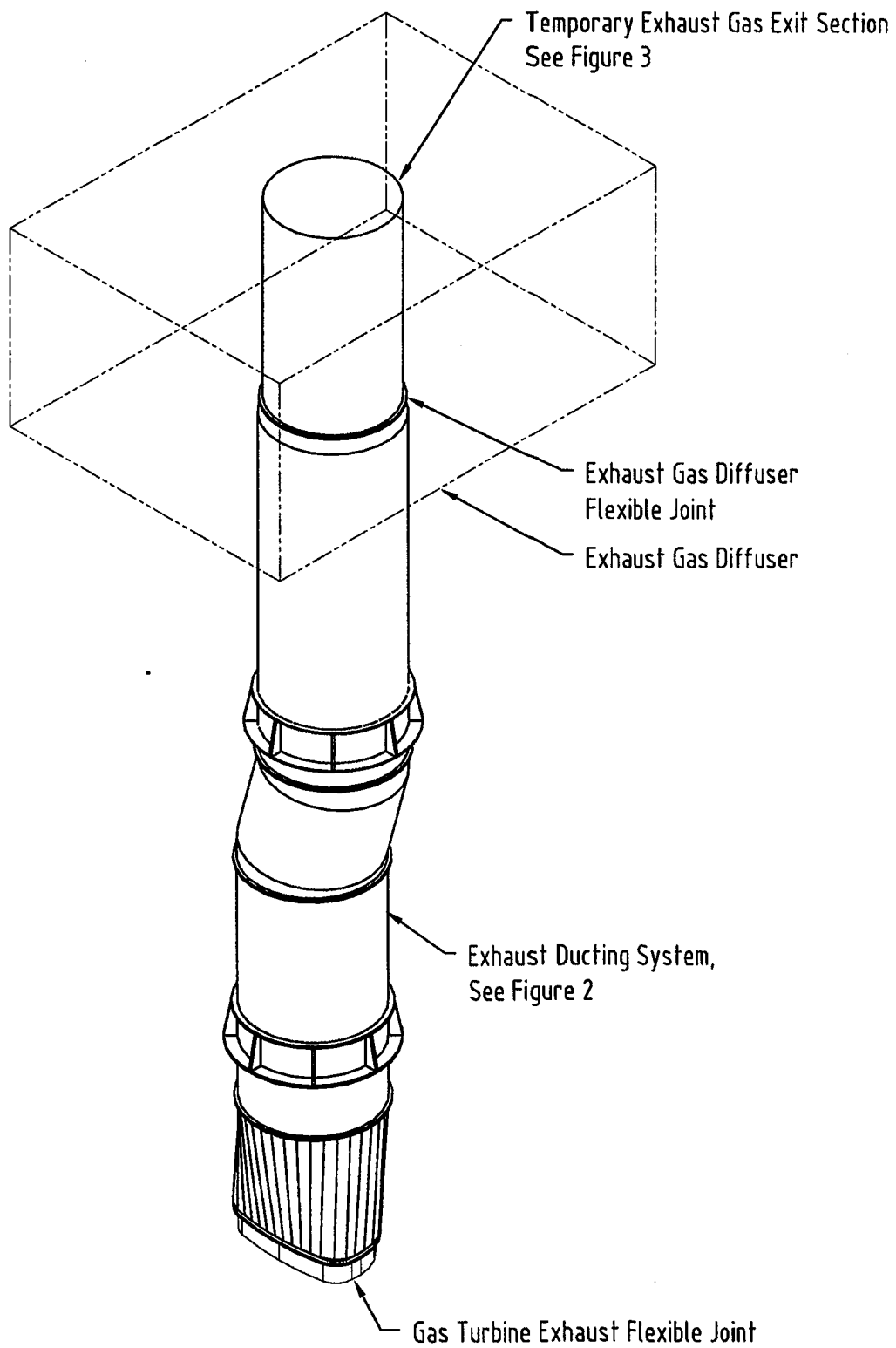


FIGURE 1
Exhaust Ducting System Isometric

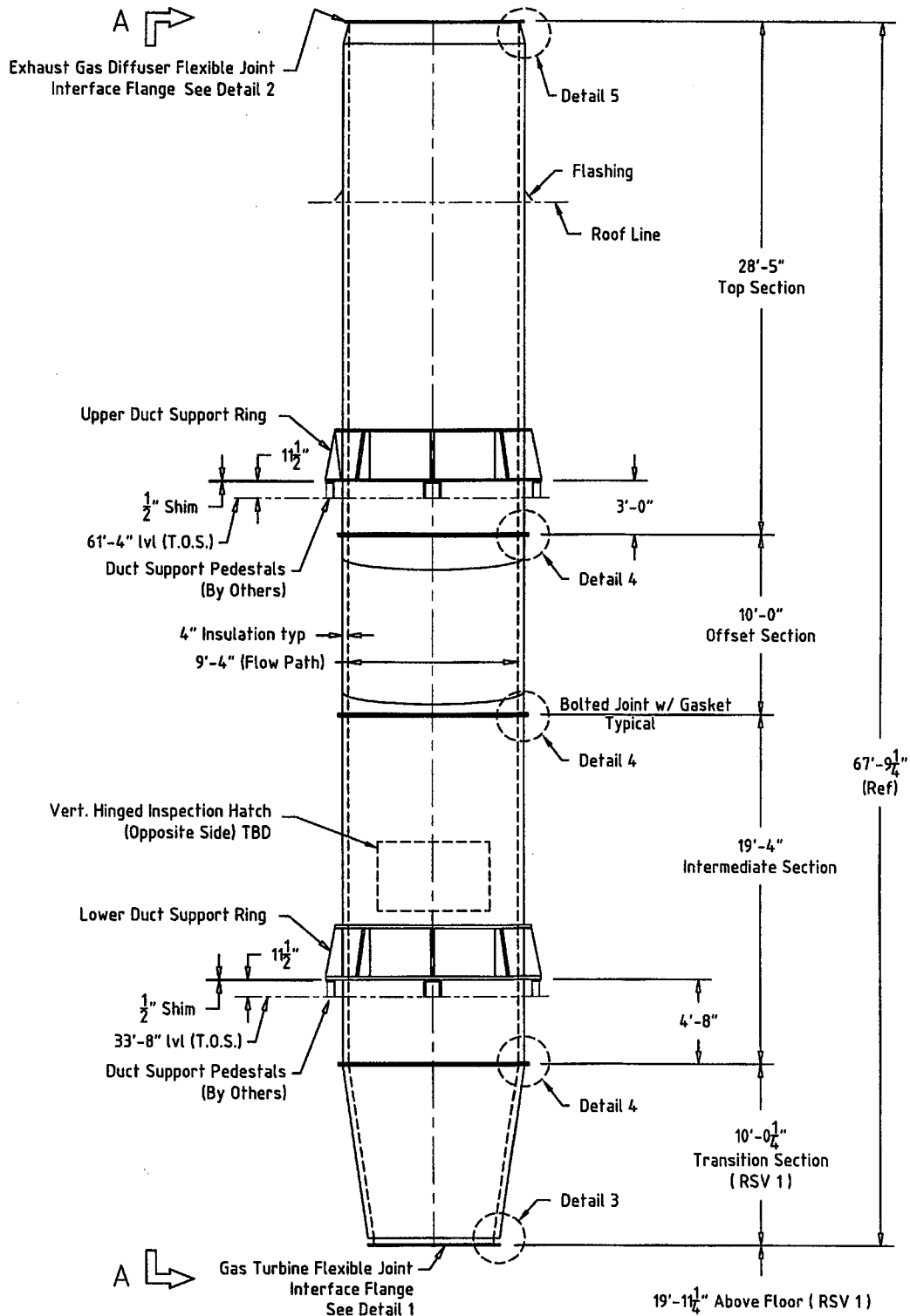
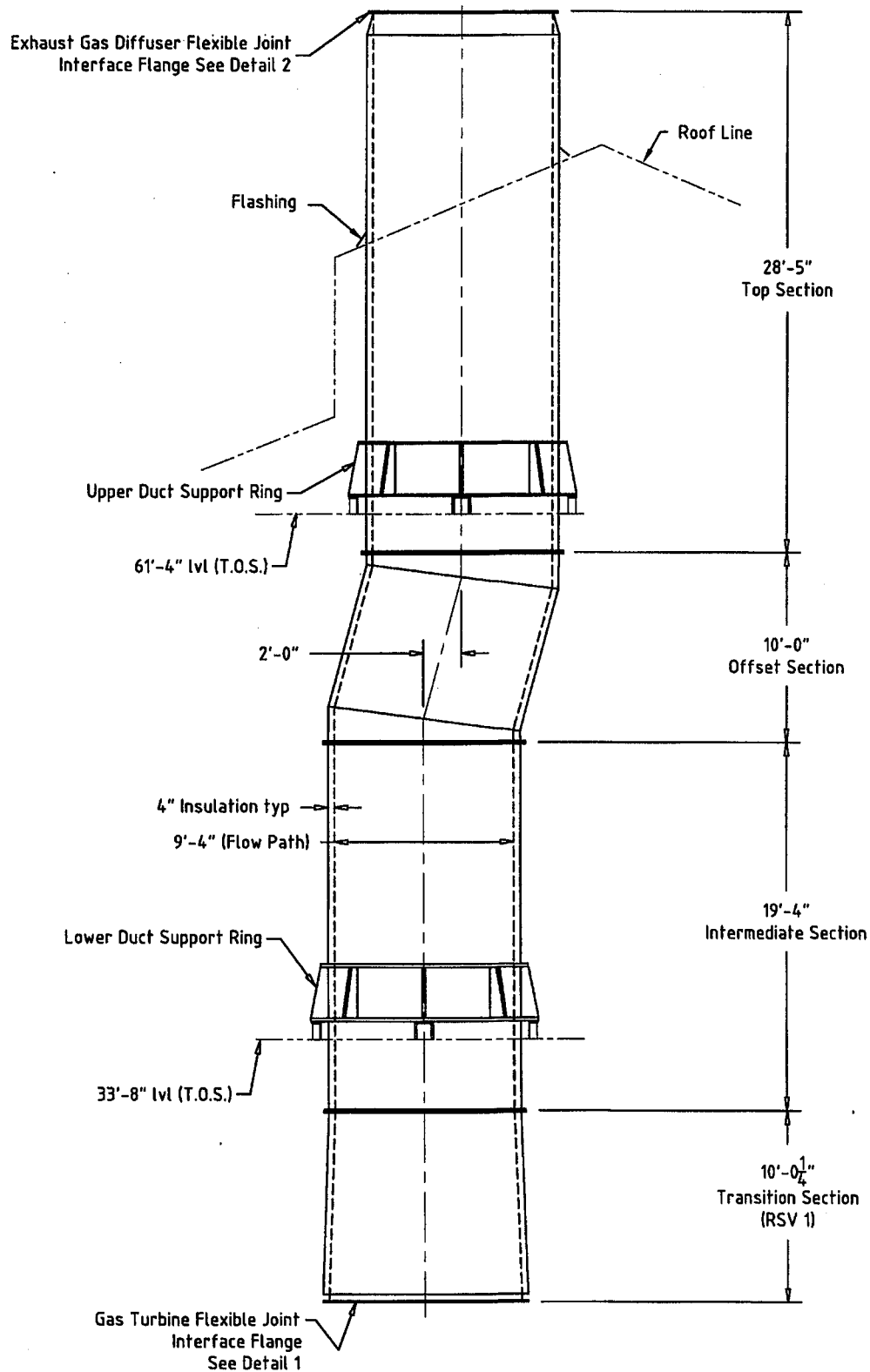


FIGURE 2
Exhaust Duct System Arrangement and Details
Reservation 1: Height Reserved Pending Gas Turbine Final Interface Information



VIEW A-A
Exhaust Duct System (Side View)

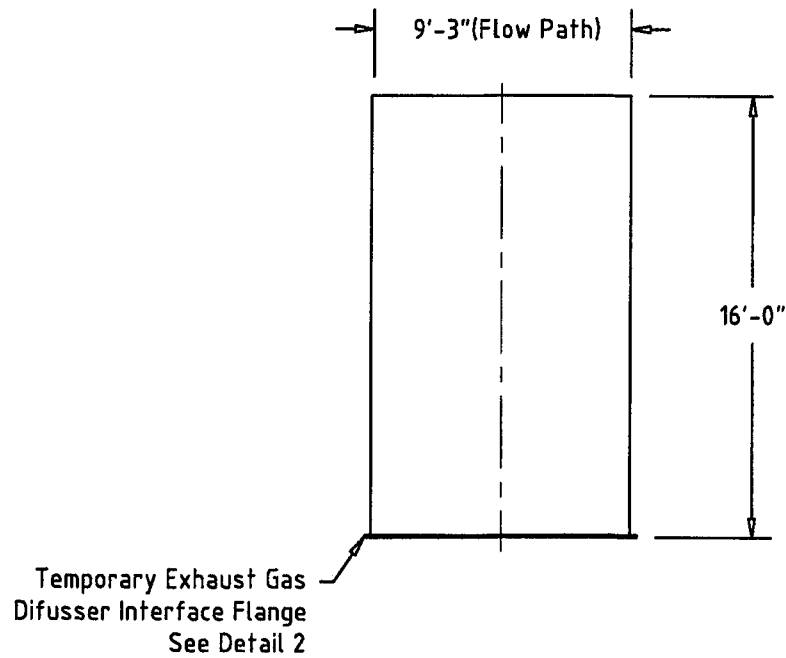
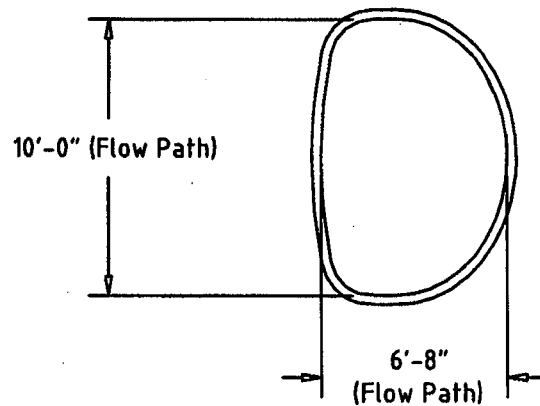
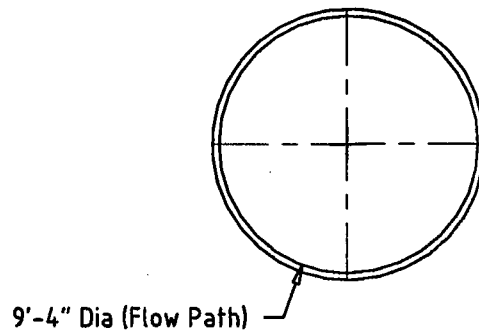


Figure 3
Temporary Exhaust Gas Exit Section



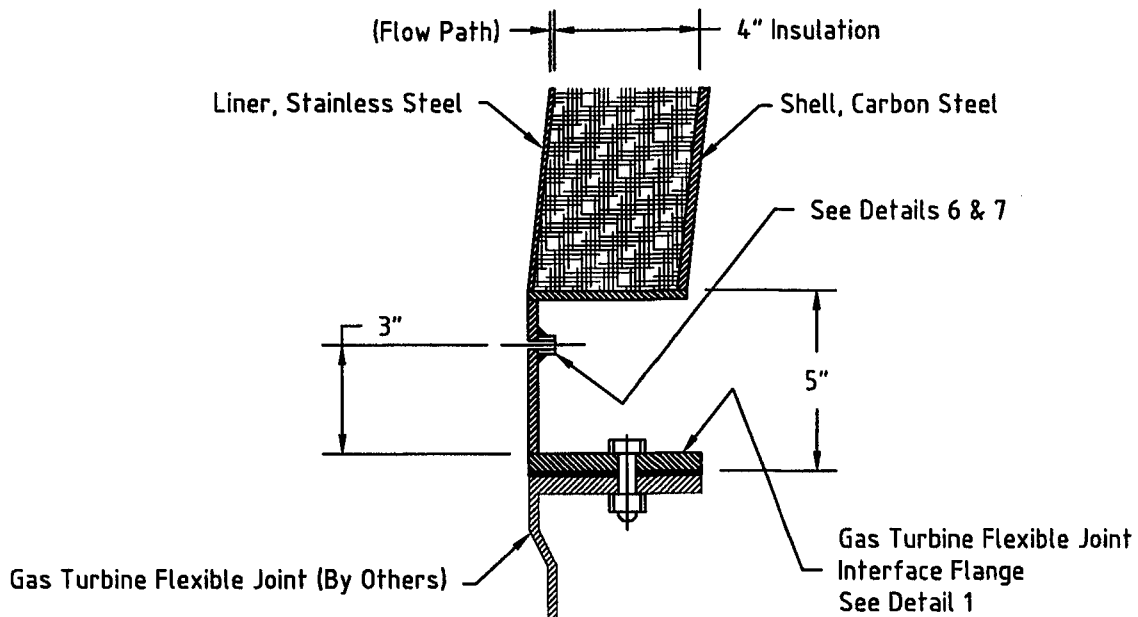
(Bolt Hole Pattern to be Provided by the Government Within 10 days of Award)

DETAIL 1
Gas Turbine Flexible Joint Interface Flange

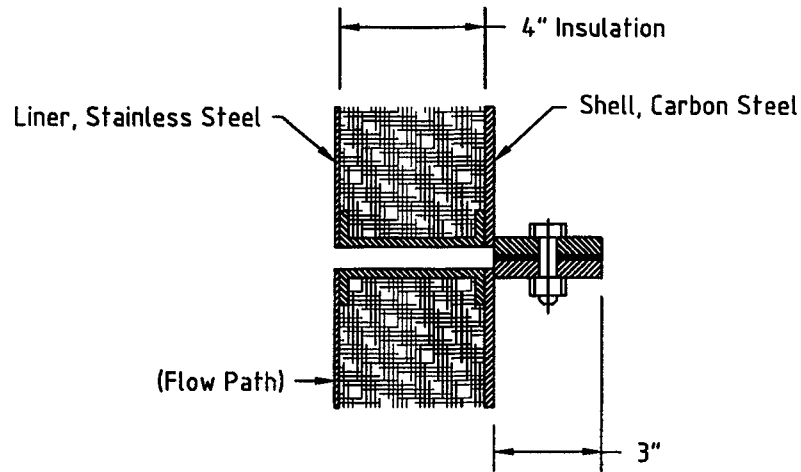


(Flange OD and Bolt Pattern to be Provided by the Government Within 10 days of Award)

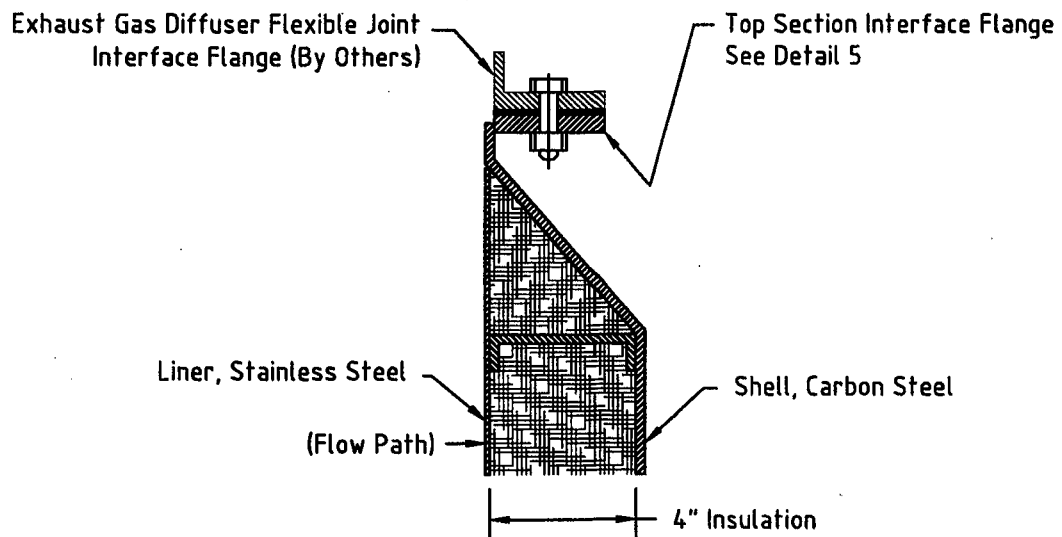
DETAIL 2
Exhaust Gas Diffuser
Interface Flange



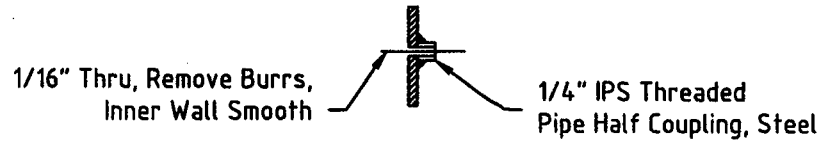
DETAIL 3
Transition Section
Pressure Tap Detail



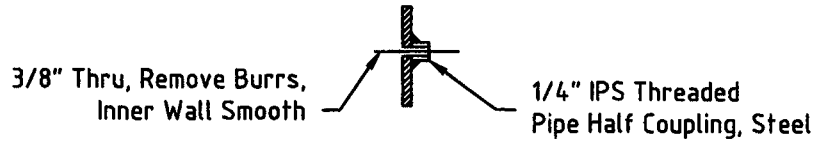
DETAIL 4
Wall Section / Interconnection Detail



DETAIL 5
Top Section
Connection Detail



DETAIL 6
Pressure Connection Detail



DETAIL 7
Temperature Connection Detail

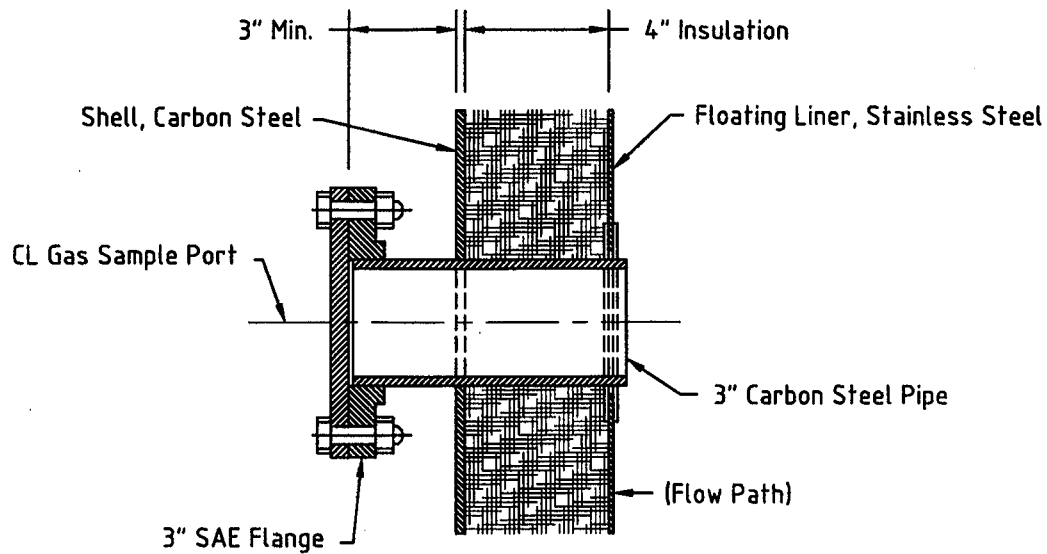


Figure 4
3" Gas Test Port

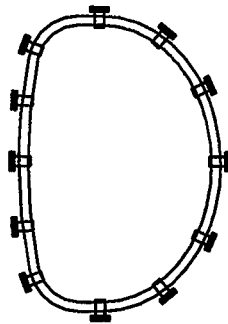


Figure 5
Gas Sample Port Arrangement
at the Below 32' Level